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PENSOFT

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The genus *Colydium* Fabricius in Europe (Coleoptera, Zopheridae, Colydiinae) with description of a new species, *Colydium noblecourti* sp. nov.

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Abstract

A new species of the genus *Colydium* Fabricius, 1792 (Coleoptera, Zopheridae, Colydiinae), *Colydium noblecourti* **sp. nov.** is described. An illustrated and updated key for the identification of the Western Palearctic species of *Colydium* is presented. Distribution maps for the three species are provided.

Key Words

Colydium elongatum, *Colydium filiforme*, cryptic species, cylindrical bark beetles, distribution, genetic analysis, identification key, morphometric analysis, taxonomy, Western Palearctic

Introduction

The family *Zopheridae* Solier, 1834 is widely distributed throughout the world. In the Palearctic region, this family is represented by 287 species grouped into 46 genera (Schuh 2020). The genus *Colydium* was revised by Węgrczynowicz (1999) and currently contains 32 species. Until now, only two species in the genus *Colydium* were known to inhabit the Palearctic area: *Colydium elongatum* (Fabricius, 1787) and *Colydium filiforme* Fabricius, 1792 (Schuh 2020). They live under the bark of dead or dying trees inside the galleries of other wood-dwelling insects. Both species are members of the saproxylic guild (Alexander 2008), although the details of their ecology are largely unstudied. They may prey on other beetles or their larvae living under the bark, or they may only clean the galleries (commensalism) (Dajoz 1977; Węgrczynowicz 1999; Bouget et al. 2019).

The authors found two different morphological forms of *Colydium* Fabricius (tentatively assigned to *C. elongatum* (Fabricius, 1787)) during past ecological and faunistic research projects. Additionally, these forms were found to occur in several countries across Europe. This initiated the present study with the aim to resolve their identities. As a result, a new species of *Colydium* is described here and a key for the three Western Palearctic species of this genus is presented to provide means of reliable identification. Recent fieldwork has yielded additional geographic country records which, together with new data on their habitat, will contribute to a better understanding of their distribution and should facilitate further studies on their ecology.

Material and methods

We studied several private and institutional collections of *Colydium* specimens sampled throughout the West Palearctic region.

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Acronyms for collections and depositories

AE Andreas Eckelt collection, Austria
AJ Anthony Jeanneau collection, France
BM Bruno Mériguet collection, France
CASP Czech Academy of Sciences, Prague, Czech Republic
CBF Heinz Bussler collection, Feuchtwangen, Germany
CEW Manfred Egger collection, Wattens, Austria
CHV Carolus Holzschuh collection, Villach, Austria
CSW Rudolf Schuh collection, Wiener Neustadt, Austria
CVM Cyrille Van Meer collection, France
FA Frédéric Arnaboldi collection, France
GP Guillem Parmain collection, France
HB Hervé Brustel collection, France
INRAE National Institute for Agricultural and Environmental Research (INRAE) Nogent-sur-Vernisson, France
IR Inaki Recalde Iruzun collection, Spain
KM Kiel Natural History Museum, Germany
LF Laurent Ferchaud collection, France
LuF Ludovic Fuchs collection, France
LL Laurent Lathuillière collection, France
LM Lilian Micas collection, France
LNEF Office National des Forets-Laboratoire National d'Entomologie Forestière Quillan, France
LV Laurent Velle collection, France
MNHNP Muséum National d'Histoire Naturelle, Paris, France
NME Naturkundemuseum Erfurt, Germany
NMW Naturhistorisches Museum Wien, Austria
OC Olivier Courtin collection, France
OR Olivier Rose collection, France
PM Philippe Millarakis collection, France
PZ Pierre Zagatti collection, France
RM Raphael Megrat collection, France
SE Sébastien Etienne collection, France
SNBS Bavarian State Collection for Zoology, Munich, Germany
ST Simon Thorn collection, Germany
TLF Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria
ZFMK Zoologisches Forschungsmuseum Alexander König, Bonn, Germany
ZMUO Zoological Museum, University of Oulu, Oulu, Finland

Morphological measurements

Morphological terminology follows Lawrence and Ślipiński (2013). In most available identification keys, the pronotal length to width ratio (PL/PW) is used to separate *C. elongatum* from *C. filiforme*. However, Węgrczynowicz (1999) suggested that this measurement may be inefficient to separate the two species. Possibly, the third West Palearctic species described herein was complicating identification. We measured the total length to maximum elytral width ratio (TL/EW) and the pronotal length to maximum pronotal width ratio (PL/PW) of 313 specimens representing all three species to test the pertinence of this ratio. Morphometric analyses and maps were made using R and Vegan package (R Core Team, 2024). The distribution maps were made using the following packages: plotKML, rnaturalearth and ggplot2 (R Core Team 2024).

The following abbreviations will be used hereafter in the article:

EL elytral length, along the suture from the base of the scutellum to the elytral apex
EW elytral width between humeri
HW maximum head width between the eyes
PL pronotal length, along the midline
PW maximum pronotal width
TL total length from frontal margin of the epistoma to elytral apex

DNA sequencing and analysis

All mitochondrial cytochrome oxidase subunit 1 (COI) barcode sequences from 29 *Colydium* specimens as well as the outgroup sequence (*Lasconotus jelskii* (Wankow)) are accessed from the Barcode of Life Data System (BOLD; Ratnasingham and Hebert 2007). Samples from 14 *Colydium* individuals were collected by the authors (all samples from Austria and Italy) and made publicly available via BOLD. The COI barcode samples from all the *Colydium* specimens were processed at the Canadian Centre for DNA Barcoding (CCDB, Biodiversity Institute of Ontario, University of Guelph) according to the standard high-throughput protocol described in De Waard et al. (2008). We used the Kimura's 2-parameter model of nucleotide substitution and analytical tools in the BOLD systems v. 3.0. (http://www.boldsystems.org) to calculate the degree of intra- and interspecific variation of the COI barcode fragment. The maximum likelihood (ML) tree was constructed via the Phylosuite v.1.2.2 platform (Zhang et al. 2020). The following plugins were used: The alignment was performed with MAFFT v7.313 (Katoh and Standley 2013). The best fitting model was calculated with Modelfinder (IQ-TREE v.1.6.8) (Kalyaanamoorthy et al. 2017) and the maximum likelihood phylogenies were inferred using IQ-TREE v (Nguyen et al. 2015) under Edge-linked partition model for 1000 ultrafast (Minh et al. 2013) bootstraps. The tree was visualized with FigTree v1.4.4 (Rambaut 2015) and edited in Adobe Photoshop version 25 (Adobe Inc. (2024)).

The sequences are publicly available in the Dataset DS-COL0815 (*Colydium* species in Europe) on the BOLD homepage (https://www.boldsystems.org/index.php), and the respective BOLD-IDs are listed in Table 1.

Table 1. List of Sequence ID`s with country of origin and depository information.

BOLD-ID	Sample ID	COI-5P bp-Length	Country	Depository
TDAAT1092-20	ABOL-BioBlitz 2019 19-1071	614[0n]	Austria	NMW
FBCOB785-10	BC ZSM COL 01640	658[0n]	Germany	SNBS
PSFOR791-13	BC-PNEF-PSFOR0668	658[0n]	France	LNEF
FBCOJ850-13	BCZSM_COLA_01705	658[0n]	Austria	SNBS
FBCOJ851-13	BCZSM_COLA_01706	658[0n]	Austria	SNBS
FBCOJ852-13	BCZSM_COLA_01707	658[0n]	Austria	SNBS
FBCOJ854-13	BCZSM_COLA_01709	658[0n]	Austria	SNBS
FBCOH482-12	BFB_Col_FK_6466	605[0n]	Germany	SNBS
GBCOC535-12	GBOL_Col_FK_1770	658[0n]	Germany	SNBS
GBCOF156-13	GBOL_Col_FK_5571	658[0n]	Germany	SNBS
GBCOD830-13	GBOL_Col_FK_5770	658[0n]	Germany	SNBS
GBCOD950-13	GBOL_Col_FK_5985	627[0n]	Germany	SNBS
AALCO178-17	TLMF Col 00463	658[0n]	Italy	TLF
AALCO181-17	TLMF Col 00466	658[0n]	Austria	TLF
AALCO182-17	TLMF Col 00467	658[0n]	Austria	TLF
AALCO183-17	TLMF Col 00468	658[0n]	Austria	TLF
AALCO185-17	TLMF Col 00470	618[0n]	Austria	TLF
ABBAT203-16	TLMF Col. 00203	658[0n]	Austria	TLF
ABBAT204-16	TLMF Col. 00204	658[0n]	Austria	TLF
ABBAT205-16	TLMF Col. 00205	658[0n]	Austria	TLF
AALCO094-16	TLMF Col. 00379	658[0n]	Italy	TLF
GCOL7655-16	ZFMK-TIS-2511588	658[0n]	Germany	ZFMK
GCOL7678-16	ZFMK-TIS-2511657	658[0n]	Germany	ZFMK
GCOL7679-16	ZFMK-TIS-2511658	658[0n]	Germany	ZFMK
GCOL7680-16	ZFMK-TIS-2511659	658[0n]	Germany	ZFMK
GCOL11496-16	ZFMK-TIS-2530109	658[0n]	Germany	ZFMK
GCOL11624-16	ZFMK-TIS-2530820	658[0n]	Germany	ZFMK
GCOL12018-16	ZFMK-TIS-2532271	658[0n]	Germany	ZFMK
GCOL12030-16	ZFMK-TIS-2532288	658[0n]	Germany	ZFMK
LEFIJ2542-15	ZMUO.023616	658[0n]	Finland	ZMUO

Results

We studied 830 specimens of *Colydium* from various collections. Type specimens for the European species were studied through high quality pictures provided by Dr. Michael Kuhlmann from the Zoological Museum of Kiel University.

Colydium noblecourti sp. nov.

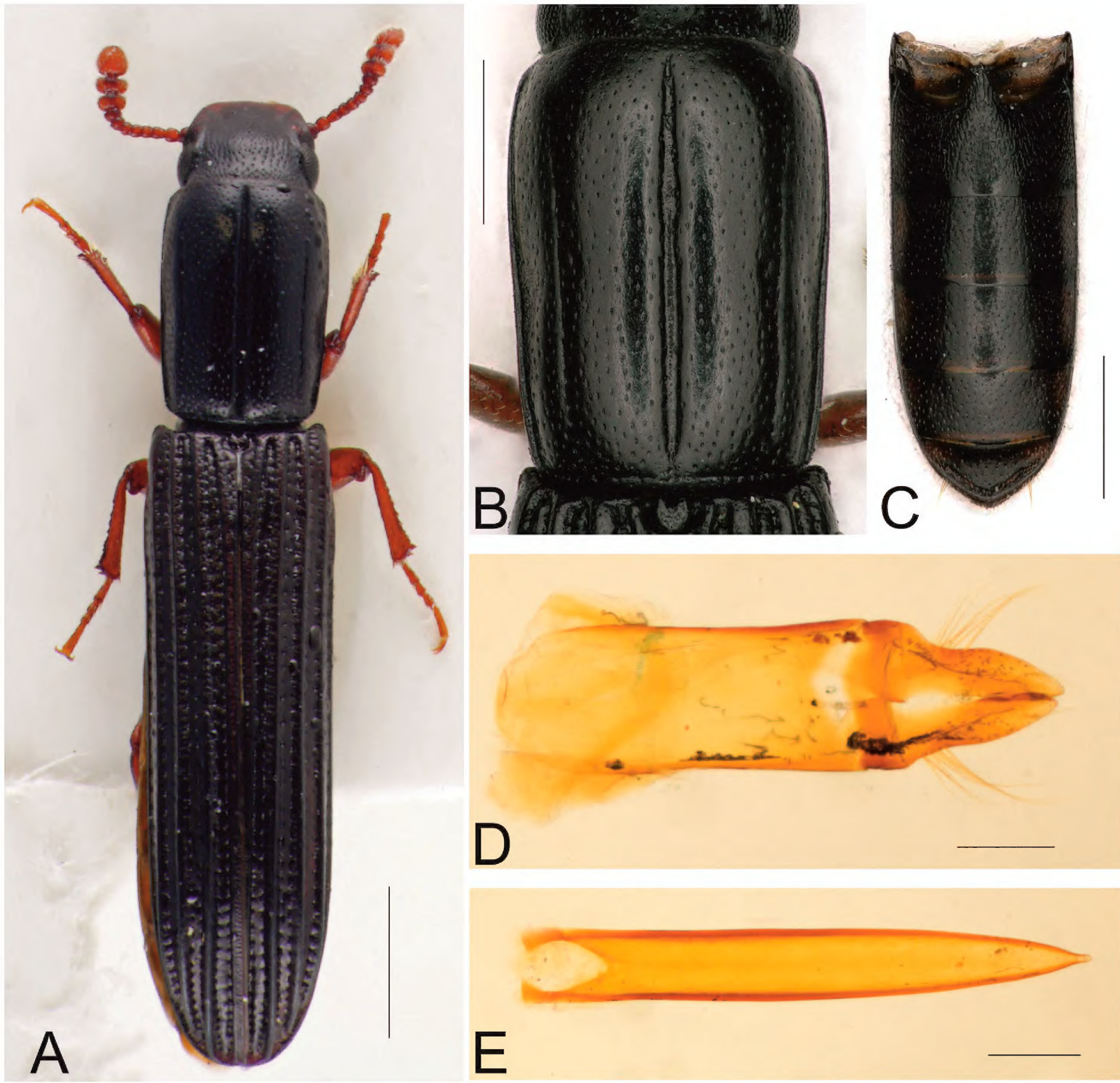
https://zoobank.org/F7254A03-E80C-458A-8B8A-73DD9CF22527

Figs 1A–E, 5, 6

Type locality. Austria, Wien, 13. Bezirk, Lainzer Tiergarten, Johannserkogel, 320 m a.s.l., 48°11'36"N, 16°13'10"E.

Type material. ***Holotype*** • ♂ (Fig. 1A–E); Original label: "AUT. W. Lainzer Tiergarten, Johannserkogel N, 16.21968/48.19335 320 m, 28.IV.2016 leg. Eckelt A." "DNA Barcode, TLMF Col 00203" "HOLOTYPE ♂, Colydium noblecourti sp.nov., des. Parmain, Eckelt and Schuh 2024 [red printed label]" (TLF). ***Paratypes***. (250 exx.); **Andorra** • 1 ♀; La Massana; 16. Jan. 1998, H. Brustel leg. (HB) • 3 ♂; La Massana, 25. Feb. 2008, H. Brustel leg. (HB). **Austria** – **Wien** • 1 ♀; Lainzer Tiergarten; 24. Jul. 1965; Vogl leg. (CSW) • 1 ♂; Lainzer Tiergarten; 8. May 1996; E. Holzer leg. (CSW) • 1 ♂; Lainzer Tiergarten, 2. Jul. 1966; C. Holzschuh leg. (CSW) • 1 ♂; Lainzer Tiergarten, Johannser Kogel, Nordseite, 300 m a.s.l.; 19. Apr. 1995; M. Kahlen leg. (TLF) • 1 ex.; Lainzer Tiergarten, Aug. 1954; F. Schubert leg. (NMW) • 1 ex.; Lainzer Tiergarten, 29. Jul. 1951; C. Holzschuh leg. (CHV) • 1 ex.; Lainzer Tiergarten, 6. Sep. 1969; C. Holzschuh leg. (CHV) • 1 ex.; Lainzer Tiergarten, 14. May 2007; W. Hansely leg. (CSW) – **Niederösterreich** • 2 exx.; Wienerwald; Kubinyi leg. (CHV) • 1 ex.; Wien Umgebung, Mariabrunn; 22. May 1966; C. Holzschuh leg. (CHV) • 2 exx.; Lunz; Kaufmann leg. (NMW) • 1 ex.; Wien Umgebung; Haberditz leg. (NMW) • 1 ex.; Wien Umgebung; Hoffmann leg. (NMW) • 1 ex.; Klosterneuburg, Donau-Auen; 7. Apr. 1947; Lechner leg. (NMW) • 1 ex.; Klosterneuburg, Wienerwald; 8. Apr. 1947; Lechner leg. (NMW) • 2 exx.; Pressbaum; 21. Mar. 1948; Lechner leg. (NMW) • 1 ♂, 1 ♀; Bez. Wiener Neustadt, Bad Fischau, Kürassier, 400 m a.s.l.; 15. Apr. 1990; R. Schuh leg. (CSW) • 1 ♂, 1 ♀; Wiener Neustadt, 1 km SSE Feuerwerksanstalt; 7. Jan. 2007; R. Schuh leg. (CSW) • 1 ♀; Bez. Neunkirchen, Raxgebiet, Hinternasswald, 800 m a.s.l.; 23. May 2005; W. Hansely leg. (CSW) • 1 ♀; Wiener Neustadt, Föhrenwald; 10. Apr. 1993; R. Schuh leg. (CSW) • 1 ♂; Bez. Baden, Helenental, Hoher Lindkogel, Nordseite, Umg. Cholerakapelle, 300 m a.s.l.; 11. May 2024; R. Schuh leg. (CSW) • 1 ♂; Neulengbach; 2. Apr. 1980; A. Dostal leg. (CSW) – **Burgenland** • 6 ♂, 6 ♀; Bez. Mattersburg: Gruskogel Westseite 4 km SSW Marz; 450 m a.s.l.; 8. Apr. 2007; R. Schuh leg. (CSW) – **Steiermark** • 2 exx.; Bez. Hartberg-Fürstenfeld, Vorau;

28. Apr. 1958; C. Holzschuh leg. (CHV) • 3 ♂; Gams bei Frohnleiten; Gamsgraben; 47°18'23,5"N, 15°14'49,3"E; 25. Jul. 2011; A. Eckelt leg. (AE) • 2 exx.; Gams o F; Apr. 1966; (NMW) – **Kärnten** • 8 exx.; Bez. Klagenfurt Land, Forchsee; 9. Mar. 1999; C. Holzschuh leg. (CHV, CSW) • 1 ex.; Bez. Villach Land: Gerlitzen, Deutschberg; 1300 m a.s.l.; 10. Jul. 2010; C. Holzschuh leg. (CHV) • 3 exx.; Bez. Spittal an der Drau, Siflitzberg; Konschegg leg. (NMW) • 2 exx.; Villach; Holdhaus leg. (NMW) • 1 ♀; Hermagor; 12. May 1964; C. Holzschuh leg. (CHV) • 1 ♀; Bez. Spittal an der Drau, Edling; 14. Feb. 1961; C. Holzschuh leg. (CHV) • 1 ♂; Bez. Klagenfurt Land, Kreuzbergl; 6. Mar. 1990; R. Preiss leg. (CSW) • 1 ex.; Eisenkappel; 20. Jun. 1968; (NMW) – **Osttirol** • 1 ex.; Lienz, Weg nach Bannberg; 2. Apr. 1967; A. Kofler leg. (TLF) • 1 ♂; Lienz, Tristacher See; 26. Jul. 1961; C. Holzschuh leg. (CHV) – **Tirol** • 1 ex.; Karwendel, Absam N, Egg SW, Heuberg-Latschen; 985 m a.s.l.; 10. Apr.– 8. May 2016; M. Kahlen leg; window trap (TLF) • 1 ex.; Karwendel, Absam N, Egg SW, Heuberg-Flecke; 1000–1050 m a.s.l.; 20. Dec. 2015; M. Kahlen leg. (TLF) • 1 ex.; Karwendel, Absam N, Egg SW, Heuberg-Latschen; 1036 m a.s.l.; 8. May – 7. Jun. 2016; M. Kahlen leg.; window trap (TLF) – **Oberösterreich** • 1 ♀; NP Kalkalpen, Brandfläche Hagler; 47°46'24"N, 14°17'48"E; 1500 m a.s.l.; 7. Jul. 2011; A. Eckelt leg. (AE) • 1 ♀; NP Kalkalpen, Bodinggraben, östl. Gamskitzgraben; 47°47'03,1"N, 14°22'16,5"E; 700 m a.s.l.; 7. Jul. 2011; A. Eckelt leg. (AE). **Bosnia** • 3 exx.; District Mostar, Blagaj; 12. Apr. 1920 (NMW). **Croatia** • 1 ♀; ex coll. Oberthür; (CSW). **Czech Republic** • 5 ♂, 1 ♀; floodplain of Lower Morava, Dyje; 24. Apr.–16. May 2012; S. Vodka, D. Hauck & L. Cizek leg. (CASP) • 2 ♀; Beskiden [Beskydy mountains]; Borth leg. (CSW, CHV) • 1 ♂; Moravia, Brno; 22. Feb. 1997; P. Čechovsky leg. (CSW) • 1 ♂; central Bohemia, Loučeň; 21. May 2004; L. Daněk leg. (CSW). **France** • 1 ex.; Aube, Maraye-en-Othe; 14. Apr. 2007; F. Soldati leg. (LNEF) • 2 exx.; Loiret, Nogent-sur-Vernisson, Domaine des Barres; 20. Jun. 2022; G. Parmain & C. Moliard leg. (GP) • 1 ♂,1 ♀; Loiret, Nogent-sur-Vernisson, Domaine des Barres; 3. May 2023; G. Parmain & C. Moliard leg. (GP) • 1 ♀; FD Bercé; 13. May 2014; A. Jeanneau leg. (AJ) • 1 ♀; Bois du Château d'Angervilliers; 27. May 2020; B. Mériguet leg. (BM) • 1 ♂, 2 ♀; FD Chantilly; 27. Apr. 2022; C. Moliard leg. (GP) • 2 ♂, 6 ♀; FD Chantilly; 25. May 2022; C. Moliard leg. (GP, INRAE) • 1 ♂, 1 ♀; FD Rambouillet; 3. Feb. 2004; F. Arnaboldi leg. (FA) • 1 ♀; Rambouillet; 19. Mar. 2003; B. Mériguet leg. (PZ) • 1 ♂; FD Rambouillet; 30. May – 30. Jun. 2006; C. Bouget leg. (INRAE) • 1 ♂; FD Rambouillet; 25. Sep. 2006; C. Bouget leg. (INRAE) • 1 ♀; FD Hautil; 21. Jul. 2003; F. Arnaboldi leg. (FA) • 1 ♀; Forêt de St Colombe; 23. Feb. 1999; H. Brustel leg. (HB) • 1 ♂; Armainvilliers; 10. May 2001; C. Bouget leg. (INRAE) •2 ♂, 1 ♀; Armainvilliers; 11. May 2001; C. Bouget leg. (INRAE) • 1 ♀; Armainvilliers; 8. Jun. 2001; C. Bouget leg. (INRAE) • 3 ♂, 2 ♀; Belesta; 13. Jun. 2017; C. Bouget leg. (INRAE)" • 3 ♀; Belvis; 13. Jun. 2017; C. Bouget leg. (INRAE) • 1 ♂; Belvis; 13. Jun. 2017; C. Bouget leg. (PZ) • 1 ♂; Belvis; 1. Jul. 1997; LNEF staff leg. (LNEF) • 1 ♀; Espezel; 13. Jun. 2017; C. Bouget leg. (INRAE) • 1 ♀; FD Karstenwald; 3. Jun. 2009;C. Bouget leg. (INRAE) • 1 ♀; FD Orléans; 6. Jun. 2019; INRAE staff leg. (INRAE) • 1 ♂, 1 ♀; Ferrières-en-brie; 10. May 2001; C. Bouget leg. (INRAE) • 1 ♀; Ferrières-en-brie; 11. May 2001; C. Bouget leg. (INRAE) • 1 ♂; Ferrières-en-brie; 8. Jun. 2001; C. Bouget leg. (PZ) • 1 ♀; Ferrières; 10. May – 5. Jun. 2001; C. Bouget leg. (INRAE) • 1 ♂, 1 ♀; Fougax-et-Barrineuf; 13. Jun. 2017; C. Bouget leg. (INRAE) • 8 ♂, 4 ♀; Gambaseuil; 24. Apr. 2007; C. Bouget leg. (INRAE) • 1 ♀; Gambaseuil; 24. Apr. 2007; C. Bouget leg. (PZ) • 2 ♂, 1 ♀; Gex; 20. Jul. 2013; C. Bouget leg. (INRAE) • 1 ♀; Saint-Laurent; 30. May 2016; C. Bouget leg. (INRAE) • 1 ♀; Saint-Laurent-du-Pont; 23. Jun. 2014; P. Janssen leg. (INRAE) • 6 ♂, 2 ♀; Vouzeron; 30. May 2016; C. Bouget leg. (INRAE) • 1 ♀; Bussac; 21. May – 4. Jun. 2019; LNEF staff leg. (LNEF) • 1 ♀; FD Verrières; 14. – 22. Apr. 2003; LNEF staff leg. (LNEF) • 1 ♀; Nebias; 8. Mar. 1994; LNEF staff leg. (LNEF) • 1 ♀; RNN Cerisy; 29. Apr. 2018; S. Etienne leg. (LNEF) •1 ♀; RNN Cerisy; 16. May 2018; S. Etienne leg. (LNEF) • 1 ♀; Ft. pays des étangs; 2. May 2018; L. Fuchs leg. (LuF) • 1 ♀; Marckolsheim, RB Rhinvald; 9. May 2018; L. Fuchs leg. (LuF) • 1 ♂; FD Campagne; 4. Jun. 2019; L. Velle leg. (LV) • 1 ♂; FD Campagne; 12. May 2021; L. Velle leg. (LV) • 1 ♀; FD Campagne; 9. Jun. 2021; L. Velle leg. (LV) • 1 ♀; Saint-Maurice; 15. Jun. 2010; O. Rose leg. (OR) • 1 ♀; Bareilles; 14. Jun. 2017; C. Bouget leg. (PZ) • 1 ♂; Le Val St Germain; 25. May 2021; B. Mériguet leg. (BM) • 1 ♂; Larrau (Iraty); 22. Feb. 2017; C. Van Meer leg. (CVM) • 1 ex.; Pyrénées Atlantiques, Iraty, Forêt d'Iraty; 5. Jun. 1998; H. Brustel leg. (CSW) • 1 ♂; Ardengost; 14. Jun. 2017; C. Bouget leg. (INRAE) •1 ♂; Comus; 13. Jun. 2017; C. Bouget leg. (INRAE) • 1 ♂; Hèches; 14. Jun. 2017; C. Bouget leg. (INRAE) • 1 ♂; Niort-de-Sault; 13. Jun. 2017; C. Bouget leg. (INRAE) • 1 ♂; FD Vierzon-Vouzeron; 7. May 2019; Canopee team leg. (INRAE) • 2 ♂; FD Fontainebleau; 13–15. May 2008; LNEF staff leg. (LNEF) • 1 ♂; FD St. Antoine; 22. May 2021; LNEF staff leg. (LNEF) • 1 ♂; Combe Lavaux; 18. May 2021; LNEF staff leg. (LNEF) • 1 ♂; ZNIEFF Puits d'Enfer; 4. May 2021; LNEF staff leg. (LNEF) • 1 ♂; La Broque; 25. Apr. 2011; L. Fuchs leg. (LuF) • 1 ♂; La Wantzenau, RB confluence III-Rhin; 7. May 2018; L. Fuchs leg. (LuF) • 1 ♂; La Wantzenau, RB confluence III-Rhin; 22. May 2018; L. Fuchs leg. (LuF) • 1 ♂; La Wantzenau, RB confluence III-Rhin; 16. Jul. 2018; L. Fuchs leg. (LuF) • 1 ♂; FD Vallée Doller, Oberbruck; 31. May 2017; L. Fuchs leg. (LuF) • 1 ♂; FD Vallée Doller, Oberbruck; 26. Jul. 2017; L. Fuchs leg. (LuF) • 1 ♂; FD Vallée Doller, Oberbruck; 1. Jun. 2018; L. Fuchs leg. (LuF) • 1 ♂; FD Vierzon-Vouzeron; 16. May 2014; L. Velle leg. (LV) • 1 ♂; Saint-Barthélemy-de-Séchilienne, ile Falcon; 13. Aug. 2019; Y. Braud leg. (OC) • 1 ♂; Saint-Barthélemy-de-Séchilienne, ile Falcon; 17. Aug. 2019; Y. Braud leg. (OC) • 1 ♂; Moussey;



Figures 1. A–E. Holotype of *Colydium noblecourti* sp. nov. **A.** Dorsal view; **B.** Dorsal view of pronotum; **C.** Ventral view of abdomen; **D.** Tegmen; **E.** Median lobe. Scale bars: 0.5 mm (**A–C**); 0.1 mm (**D, E**).

24. May 2011; O. Rose leg. (OR) • 1 ♂; Sturzelbronn; 30. Apr. 2015; P. Millarakis leg. (PM) • 1 ♂; FD de Brotonne; 23. May 2017; S. Etienne leg. (SE) • 1 ♂; FD de Brotonne; 6. Jun. 2017; S. Etienne leg. (SE) • 1 ♂; FD de Brotonne; 29. May 2018; S. Etienne leg. (SE). **Germany – Bayern** • 1 ex.; Scheidegg, NSG Rohrbachtobel; Jun. 2017; H. Bussler leg. (CBF) • 1 ex.; Ebrach, Brunnst.; 15. May 2017; S. Thorn leg. (ST) • 3 ♂, 3 ♀; Rauhenebrach; 16. Aug. 2016; S. Thorn leg. (ST) • 2 exx.; Rauhenebrach; 18. Aug. 2016; S. Thorn leg. (ST) • 3 exx.; Rauhenebrach; 25. Aug. 2016; S. Thorn leg. (ST). **Iran** • 1 ex.; Prov. Mazandaran, Now Shahr, Kheiroud Kanar Forest; 40–200 m a.s.l.; 36°36'35"N, 51°34'10"E; 3–4. May 2010; D. Frenzel leg. (NME). **Italy** • 1 ex.; Süd-Tirol [= prov. Alto Adige], Burgraviato, Bad Grill W, Gampental; 1300 m a.s.l.; 22.Jul. 2013; M. Kahlen leg. (TLF). **Slovakia** • 1 ♀; Hronská Dúbrava; 26. Apr. 2000; P. Hlaváč leg. (CSW) • 1 ♂; Bratislava, Badín; 21. Oct. 1987; I. Martinů leg. (CSW) • 1 ♀; "Hungaria: Neutraer Comitat" [= Slovakia: District Nitra]; (CSW). **Slovenia** • 18 exx.; Buje – Kozanje; 30. May 2010; M. Egger leg. (CEW, CSW) • 3 exx.; "Carniolia: Gottschee" [=Kočevje]; 1911; Naser leg. (NMW) • 3 exx.; "Untersteiermark: Windisch Landsberg" [= region Štajerska: Podčetrtek]; 1882; Ganglbauer leg. (NMW). **Spain** • 1 ex.; Prov. León, Ponferrada; Paganetti leg. (NMW). **Turkey** • 1 ex.; N Anatolia, Yenice – Karabük; May 1962; F. Schubert leg. (NMW).

Additional material. 1 ♂ (KM): "No locality on labels, no date. Paralectotypus *Bostricilus elongatus* Fabricius des. P. Wegrzynowicz". This specimen was included as a paralectotype of *Colydium elongatum* (Fabricius) by Węgrczynowicz (1999). Genitalia of this specimen were recently dissected and our studies revealed that it does not belong to *C. elongatum* but rather to *C. noblecourti*

sp. nov.. We identified this specimen by only using high resolution photographs of it and its genitalia provided by Dr. Michael Kuhlmann (KM) and were not able to study the specimen itself. Therefore, we refrain from listing it as a paratype of *C. noblecourti* sp. nov..

Etymology. The new species *Colydium noblecourti* sp. nov. is named after Thierry Noblecourt, one of the mentors of the first author. Noblecourt worked in the French National Forest Office (ONF) for many years. He developed a network of French entomologists, made huge contributions to the general knowledge of saproxylic beetles in France and raised public interest in these insects. Noblecourt is also a specialist in Symphyta (Hymenoptera) and has described several new species. The name *noblecourti* is a noun in the genitive case derived in honour of Thierry Noblecourt.

Description. ***Habitus.*** (TL 5.1–7.4 mm) relatively robust; head, pronotum, elytra and ventral side uniformly black (except in teneral specimens); legs and antennae reddish brown. Fig. 1A.

Head. (HW/PW: 0.78–0.88) Lateral margins of frons and epistoma converging towards apex, anterior margin of epistoma straight, with yellow setation; periocular carinae as long as eye. Punctures on central part of frons elongate, distance between them about 1 to 2 diameters; punctures denser and more circular on the fronto-epistomal depression. Antennomere 1 not completely visible in dorsal aspect, 1.2 times as long as wide; antennomere 2 narrower, 1.25 times as long as wide; antennomere 3 of same width as 2 and 1.2 times as long as wide; antennomeres 4 to 7 of same width (length to width ratios: 4: 1.0; 5: 1.0; 6: 0.8; 7: 0.6); antennomere 8 slightly wider than the preceding ones and 1.75 times as wide as long; antennomeres 9 to 11 form a three-segmented club (2.5 times as wide as the funicule), antennomere 9 wider than preceding ones, twice as wide as long; antennomere 10 is 1.1 times wider than 9, twice as wide as long; antennomere 11 narrower than 10 and 1.1 times as wide as long. Setation of antennomeres 4 to 8 similar in both sexes, a few longer setae occur on the inner side of antennae; antennomeres 9, 10 and 11 densely setose.

Pronotum. (PL/PW: 1.27–1.56) (Fig. 1B) In dorsal view lateral margins slightly diverging from base to apical quarter in straight line, then slightly narrowing apicad; anterior angles narrowly rounded; lateral margin bordered from base to apex; apical margin not bordered near anterior angles. Median line sulciform from anterior margin to basal transverse groove. Admedian lines slightly impressed (never sulciform), more or less obsolete on anterior third. Punctures on disc slightly elongate and 2 to 4 diameters apart. Microsculpture punctiform, microreticulated near anterior angles. Pronotal hypomera with round, small punctures, four diameters apart. Prosternum smooth, transversely wrinkled.

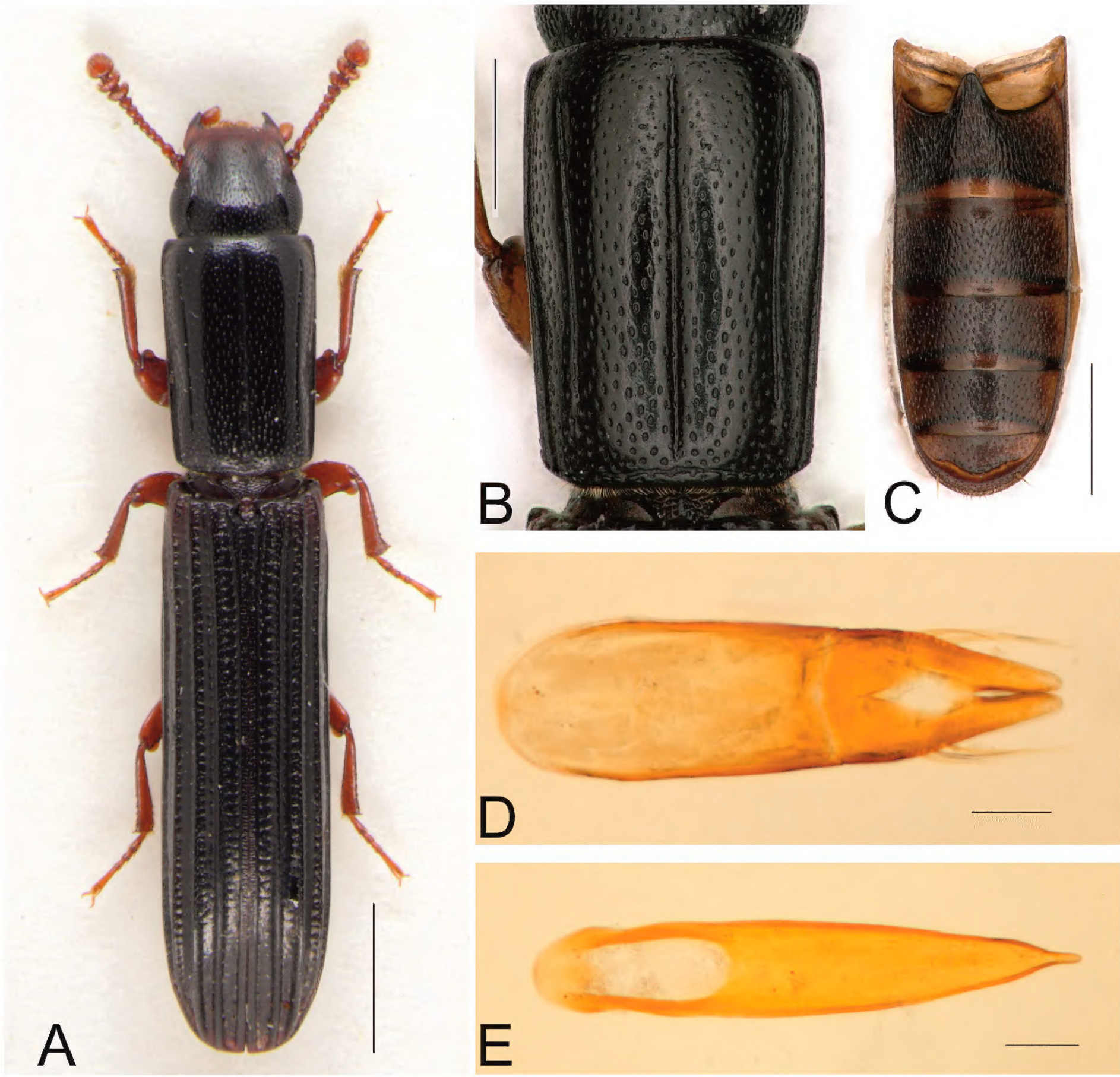
Elytra. (EL/EW: 3.00–3.31) Parallel-sided in dorsal view; humeral angles protruding forward; elytral apices conjointly broadly rounded. Striae slightly impressed; strial punctures separated from each other by a distance of 1 to 2 diameters. Sutural interval (= interval 1) raised, but not carinate except laterally along scutellary striole, flat–topped and finely wrinkled along most of its length. Uneven intervals bluntly carinate; carina on interval 3 reaching elytral apex; carina on interval 5 not reaching elytral apical rim; carina on interval 7 still shorter. Even intervals flat, smooth, indistinctly transversely wrinkled.

Ventral side of pterothorax. Mesanepisterna roughly and densely punctured. Metaventrite with complete median sulcus; very finely punctured, except for an area posterior to mesocoxae with larger punctures, partly connected by irregular lines. Metanepisterna smooth. Abdominal ventrites (Fig. 1C) shiny, weakly microreticulate, finely punctured; punctures separated by a distance of 3 to 4 diameters, each bearing very short seta; sculpture on ventrite 1 consisting of irregular wavy or zigzag lines, forming a scaly pattern; sculpture on ventrite 2 consisting of a few irregular lines or wrinkles, particularly laterad; ventrite 5 with a deep preapical groove, apical margin obtusely angled in the middle in both sexes, setose and with two groups of long setae laterally. Relative lengths of ventrites: 1: 1.9–2.2; 2: 1.3–1.5; 3: 1.2–1.4; 4: 1.0–1.2; 5: 1.0. ***Male genitalia.*** Tegmen (Fig. 1D) 4 times as long as its maximum width; basal part 2.5 times longer than parameres; parameres in dorsal aspect lamelliform, narrowed apicad, in lateral aspect s-shaped, continuously narrowed to tip; not lying in same plane, but inclined toward each other at a blunt angle; median lobe (Fig. 1E) 8 to 9 times as long as wide, 1.5 times longer than tegmen; in dorsal aspect almost parallel-sided, narrowing continuously from mid–length to apex; in lateral aspect slightly bent; apex prolonged into a narrow tip.

Variability some characters are subject to a certain degree of variation. Body proportions vary, as shown in the morphological measurements sections below. The admedian lines on the pronotum vary considerably: from absent in some specimens, only detectable by an elongate, narrow depression (minimal development) to an impressed, but irregularly interrupted line (maximal development). Elytral carina 5 is never completely connected to the apical elytral margin, but in a few cases it may reach it. The sculpture on the lateral parts of abdominal ventrite 2 is generally shallow. The extent of the sculptured area is variable.

Differential diagnosis. *Colydium noblecourti* sp. nov. can be distinguished from the two other European species of *Colydium* as follows:

From *Colydium elongatum* (Fabricius) (Fig. 2A–E) *Colydium noblecourti* sp. nov. differs in the uniformly black colour of its elytra (humeral region brown or elytral base obscurely reddish in *C. elongatum*); pronotum more globose apically; admedian lines weak, irregular and interrupted or absent; anterior pronotal angles not bordered by a prolongation of the lateral marginal line; carina on elytral interval 5 not reaching elytral apical rim; sculpture on the lateral parts of abdominal ventrites 2, 3 and 4 is less developed than on ventrite 1, or even absent, and never similar to ventrite 1; apical margin of abdominal ventrite 5 is obtusely angled in the middle (semicircular in *C. elongatum*); aedeagus with parameres that are



Figures 2. A–E. *Colydium elongatum* (Fabricius). **A.** Dorsal view; **B.** Dorsal view of pronotum; **C.** Ventral view of abdomen; **D.** Tegmen; **E.** Median lobe. Scale bars: 0.5 mm (**A–C**); 0.1 mm (**D, E**).

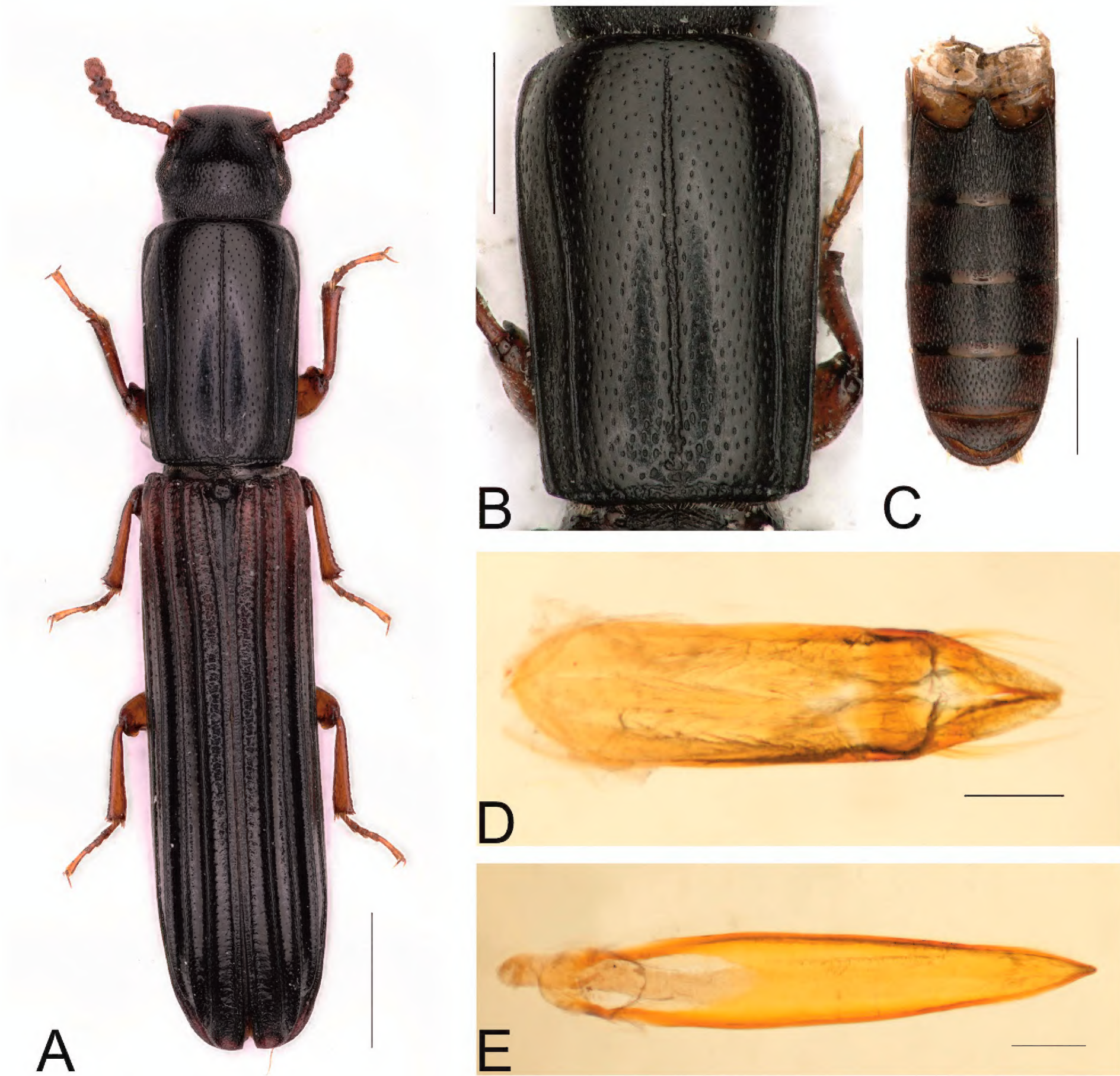
broader lamelliform, s-shaped in lateral aspect, inclined toward each other, not lying in the same plane (straight or slightly bent and narrow in *C. elongatum*).

From *Colydium filiforme* Fabricius (Fig. 3A–E) *Colydium noblecourti* sp. nov. differs in uniformly black colour of its elytra (elytral base distinctively reddish in *C. filiforme*); pronotum in general less elongate, PL/PW up to 1.56 (PL/PW up to 1.65 in *C. filiforme*) and more globose apically; admedian lines weak, irregular and interrupted or absent; anterior pronotal angles not bordered by a prolongation of the lateral marginal line; sculpture on the lateral parts of abdominal ventrites 2, 3 and 4 less developed than on ventrite 1, or even absent, never similar to ventrite 1; apical margin of abdominal ventrite 5 obtusely angled in the middle (semicircular in *C. filiforme*); aedeagus with longer median lobe, its apex is acutely angled but never prolonged into a narrow tip.

Distribution. We assume a similar distribution range as for *Colydium elongatum*. To date, *Colydium noblecourti* sp. nov. has been recorded in the following countries: Austria, Andorra, Bosnia, Croatia, Czech Republic, France, Germany, Iran, Italy, Slovakia, Slovenia, Spain and Turkey (Fig. 6).

Distribution maps of the studied material are presented for *Colydium noblecourti* sp. nov. (Fig. 6), *C. elongatum* (Fig. 7) and *C. filiforme* (Fig. 8). Since C. *filiforme* is well separated from the other European species of *Colydium*, we include locality records from Węgrczynowicz (1999).

Bionomics. The specimens were found on dead or decaying wood of the following tree genera: *Picea* A. Dietrich spp., *Abies* Miller spp., *Pinus* Linné spp. (all Pinaceae), *Fagus* Linné spp., *Quercus* Linné spp. (both Fagaceae), and *Carpinus* Linné spp. (Betulaceae).



Figures 3. A–E. *Colydium filiforme* Fabricius. **A.** Dorsal view; **B.** Dorsal view of pronotum; **C.** Ventral view of abdomen; **D.** Tegmen; **E.** Median lobe. Scale bars: 0.5 mm (**A–C**); 0.1 mm (**D, E**).

Genetic analysis

A maximum likelihood tree analysis was derived from COI barcode sequences of the three European species of the genus *Colydium*. Forming distinct clades, the support values (bootstrap with 1,000 replicates) show a robust backing for the new *Colydium* species (Fig. 4). Considering a mean interspecific distance of 4.83% (minimum 4.1%, maximum 5.6%) within the genus, *C. noblecourti* sp. nov. shows a distance of 4.3% to its closest neighbour, *Colydium filiforme* Fabricius, 1792, while the distance is more than 4.5% to *Colydium elongatum* (Fabricius, 1787).

The sequences are publicly available in the Dataset DS-COL0815 (*Colydium* species in Europe, https://dx.doi.org/10.5883/DS-COL0815) on the BOLD homepage (https://www.boldsystems.org/index.php), and the respective BOLD-IDs are listed in Table 1.

Morphological measurements

The total length to elytral width ratio (TL/EW) (Fig. 5A) does not show distinct clusters for the three species. There is mutual overlap, which does not allow a clear separation of the species by body shape alone. *Colydium filiforme* has a small range, from 4.62 to 5.28 (mean = 4.91; SD = 0.15); *Colydium elongatum* has a wide range, from 3.81 to 5.19 (mean = 4.71; SD = 0.18); and *Colydium noblecourti* sp. nov. a small range from 4.20 to 4.82 (mean = 4.60; SD = 0.13).

A similar situation can be seen for the proportions of the pronotum. The results of our measurements show no significant specific differences in the PL/PW-ratios (Fig. 5B). *Colydium filiforme* has a range, from 1.42 to 1.65 (mean = 1.53; SD = 0.05), *Colydium elongatum* from 1.35 to 1.58 (mean = 1.47; SD = 0.04) and *Colydium noblecourti* sp. nov. from 1.37 to 1.56 (mean = 1.46; SD = 0.04).

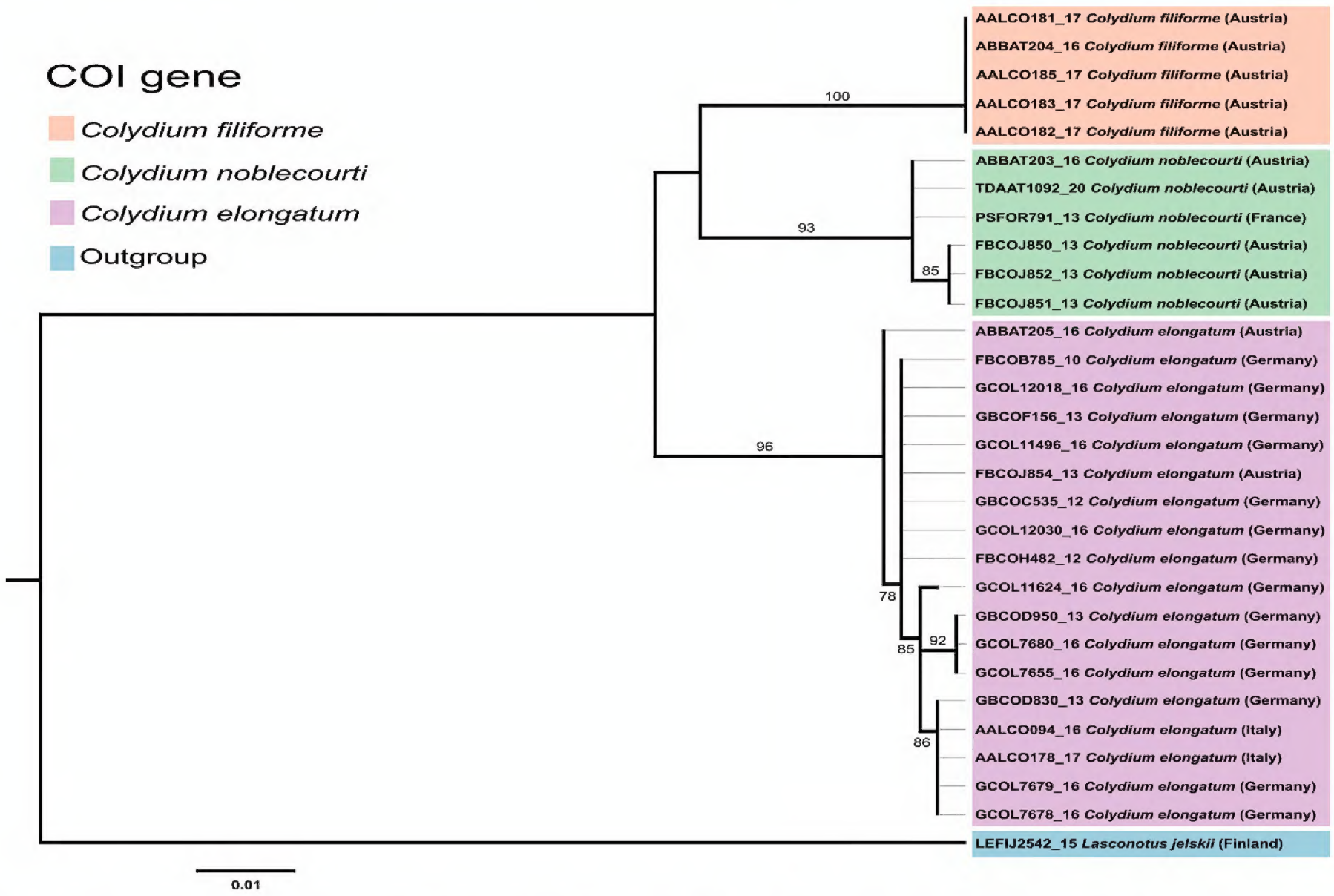


Figure 4. ML tree, based on COI barcode data for *Colydium* specimens from Austria, France, Germany and Italy. The fine, light grey branches that connect labels are not to scale. Support values (bootstrap with 1,000 replicates) are indicated on the respective branches.

The differences in the PL/PW-ratios and the TL/EW-ratios show, at most, slight specific tendencies in proportions of pronotum and body, but without diagnostic value. The PCA analysis (Fig. 5C) reflects this situation, as there is no obvious clustering of the specific data.

Ecology of Western Palearctic species of Colydium

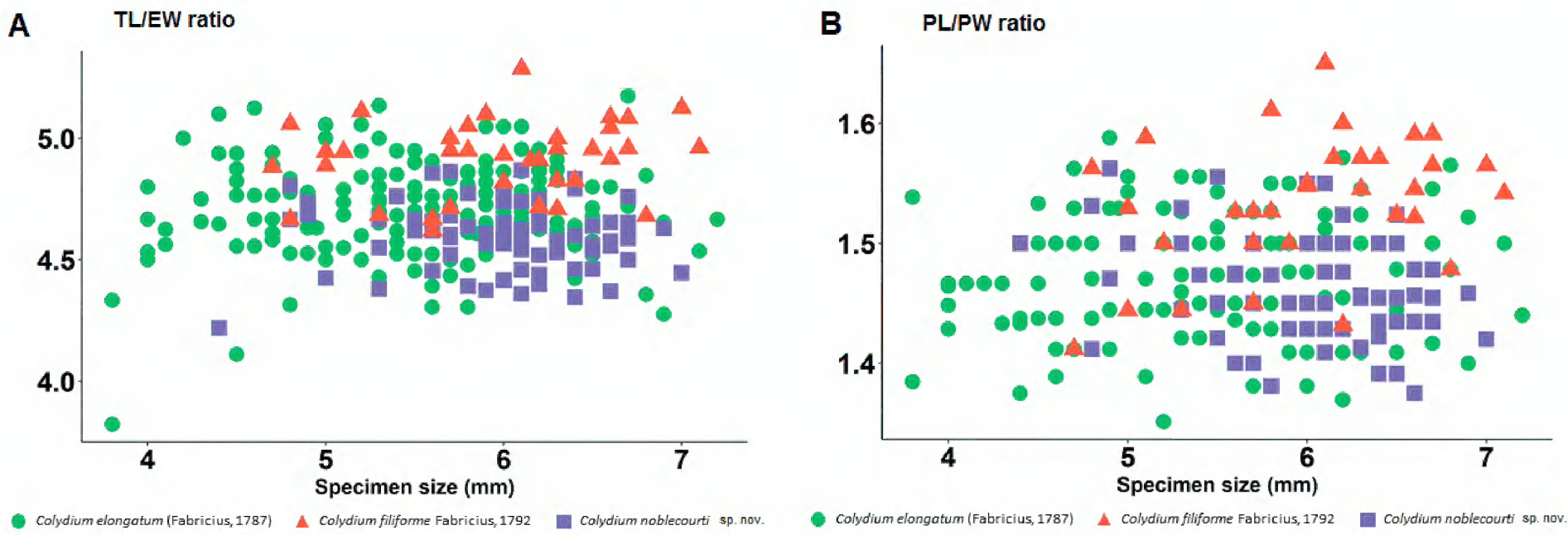
All previous publications on the ecology and biology of Palearctic *Colydium* show similar behaviour for all the species (Dajoz 1977; Węgrczynowicz 1999; Bouget et al. 2019). They live in the galleries of other saproxylic beetles. There is no clear evidence as to whether they are predators or cleaners, or possibly both depending on the stage of development (larva or adult). They are associated with different tree species.

Colydium elongatum (Fabricius) inhabits deciduous trees like *Quercus* Linné spp., *Fagus sylvatica* Linné and *Juglans regia* Linné (Juglandaceae), at least in Central Europe, but it has also been reported from coniferous trees (*Abies* Miller spp.) in France and Greece.

Colydium filiforme Fabricius has hitherto been found exclusively on *Quercus* Linné spp.

Colydium noblecourti sp. nov. seems to show a slight preference for coniferous trees (*Pinus* Linné spp., *Abies alba* Miller, *Picea abies* (Linné) H.Karsten), although it has also been found on deciduous trees like *Fagus sylvatica* Linné and *Carpinus betulus* Linné. One of the authors (R. Schuh, personal observation) has collected *C. noblecourti* sp. nov. several times in the eastern part of Austria (alluvial floodplains 200–300 m a.s.l.). All these specimens were collected by hand on dead but still standing *Pinus nigra* Arnold, under mouldy or rotten bark. The *Colydium noblecourti* sp. nov. specimens were hiding in abandoned galleries of Scolytinae (Curculionidae) or Cerambycidae. Collecting was largely carried out from December to April, although some was performed during other parts of the year, but with less success. Some specimens from other collections bear notes about collecting circumstances on their labels, which might give more information on the species bionomics. A short list of these data follows: "in galleries of *Xyloterus lineatus* (Ol.) (Curculionidae: Scolytinae) on *Picea abies* (L.) Karst." (Austria: Carinthia: Hermagor, leg. C. Holzschuh); "in galleries of *Orthotomicus laricis* (F.) (Curculionidae: Scolytinae) on *Picea abies* (L.) Karst." (Austria: Tyrol: Lienz, leg. A. Kofler); "under bark of burnt *Picea*" (Austria: Tyrol, Karwendel, leg. M. Kahlen); "under bark of *Pinus* or *Picea*" (Austria: Carinthia, several localities, leg. C. Holzschuh); "in window trap on dead *Abies alba* Mill." (Germany: Bayern, leg. H. Bussler); "on *Fagus*" (France: Forêt d'Iraty, leg. H. Brustel); "in the night on trunks of *Fagus*" (Austria: Vienna, leg. M. Kahlen); "in galleries of *Xyloterus domesticus* (L.) (Curculionidae: Scolytinae) on *Carpinus betulus* L." (Austria: Vienna, leg. C. Holzschuh).

These labels represent only single data points, however, and a full ecological analysis is therefore not yet possible. Further investigations are required to reveal the true bionomics of *C. noblecourti* sp. nov.



Figures 5. A–C. Morphometric diagrams. **A.**Total length / elytral width ratios; **B.** Pronotal length / pronotal width ratios; **C.** PCA analysis.

Identification key

Note: the three species are not easy to separate. In the authors' opinion the most efficient criterion for separating species are the male genitalia. The morphometric values proposed by Porta (1929), Dajoz (1977) and Vogt (1967) as diagnostic are not efficient, as Węgrczynowicz (1999) has already suggested. The description of *Colydium noblecourti* sp. nov. is the perfect opportunity to propose a new identification key with more useful characteristics.

1 Admedian lines of pronotum absent or only slightly impressed (Fig. 1B). Apex of apical ventrite angled in both sexes (Fig. 1C). Punctures on pronotal base on average smaller (separated by one to two of their diameters), of same size as on pronotal disc. Elytra generally completely black. Aedeagus as in Fig. 1D, E. Parameres not in the same plane, inclined toward each other; the apex of median lobe prolonged into a narrow tip (Fig. 1E) ..... *Colydium noblecourti* sp. nov.

– Admedian lines of pronotum strongly impressed (Figs 2B and 3B). Apex of apical ventrite rounded (Figs 2C and 3C). Punctures on pronotal base on average larger (separated by half to 1.5 of their diameters), larger and denser than on pronotal disc. Humeral angles of the elytra at least with a brown spot or the basal third of the elytra completely reddish. Aedeagus differently shaped 2

2 Periocular carina well defined and sharply cariniform (well visible from above). Humeral angles of elytra brown. Elytral interval 3 elevated at the apex but rounded in cross-section; carina on elytral interval 5 connected to interval 9 at apex. Aedeagus as in Fig. 2D, E. Parameres in the same plane, apex of the median lobe prolonged into a narrow tip (Fig. 2E) ..... *Colydium elongatum* (Fabricius, 1787)

– Periocular carina weak, blunt, without a distinct angle (well visible from above). Humeral angles and at least first fifth of elytra reddish brown to brown. Elytral interval 3 distinctly and sharply cariniform at apex; carina on elytral interval 5 not connected to interval 9 at apex. Aedeagus as in Fig. 3D, E. Parameres not in the same plane and inclined toward each other; apex of median lobe sharply angled, but not prolonged into a narrow tip (Fig. 3E)..... *Colydium filiforme* Fabricius, 1792

Discussion

The consistent confusion between the Western Palearctic species of *Colydium* in former times was due to inappropriate identification keys, their very similar biology and the existence of the hitherto unknown *C. noblecourti* sp. nov.. As our study shows, all three species can be separated by external characters and specific differences in male genitalia. The genetic analysis of COI barcode sequences further confirms that the morphological differences identified between the species are sufficient to distinguish them clearly.

The aim of the morphometric analysis was to test the value of length/width-ratios to describe the body shape of these species. Particularly, the PL/PW-ratio has been used widely to separate *C. elongatum* (Fabricius) and *C. filiforme* Fabricius (Vogt 1967; Dajoz 1977; Węgrzynowicz 1999). For example, the PL/PW-ratio of *C. elongatum* according to Vogt (1967) and Dajoz (1977) is 1.5 and for *C. filiforme* the PL/PW-ratio is stated as "above 1.5" (Vogt 1967) and as 1.75 (Dajoz 1977). More thorough results are published by Węgrzynowicz (1999) with PL/PW-ratio of *C. elongatum* as 1.29–1.52 and 1.41–1.66 of *C. filiforme* respectively. This shows, that the values for those ratios in previous literature are not useful for separation of the Western Palearctic *Colydium* species. In this study, with the new situation of a third species it was important to elaborate how descriptive those ratios are, including the data of *C. noblecourti* sp. nov. too. The results show that morphometric characters do not represent a reliable identification tool, particularly for separation of *C. elongatum* and *C. noblecourti* sp. nov..

All three species can be found under the same type of bark (observation by the second author). This makes the available ecological and distributional data in the literature difficult to interpret. We have provided distribution maps for each species (Figs 6–8).

C. noblecourti sp. nov. is only known from the records provided in the present study. We studied specimens from Austria, Andorra, Bosnia, Croatia, Czech Republic, France, Germany, Iran, Italy, Slovakia, Slovenia, Spain and Turkey (Fig. 6). Compared to the two other species, *C. noblecourti* sp. nov. seems more or less rare, depending on the country of origin. According to the available data, this species is more common in France than *C. filiforme*, whereas in Germany and the Czech Republic, *C. filiforme* is more common than *C. noblecourti* sp. nov. More data are needed to assess the real conservation status of this new species.

Colydium elongatum is widespread in Europe (33 countries: AB; AL; AR; AU; BE; BH; BU; BY; CR; CT; CZ; DE; FI; FR; GB; GE; GR; HU; IT; LT; MC; NL; PL; RO; SK; SL; SP; ST; SW; SZ; TR; UK; YU. Abbreviations according to Iwan and Löbl (2020)). This was the most common species among the studied material. The data we gathered suggest that it might be distributed throughout French territory, including Corsica (Fig. 7). It is considered "of least concern" in Italy (http://www.iucn.it/scheda.php?id=-1019656031) and "endangered" in Norway (https://artfakta.artdatabanken.se/taxon/100701). It is absent from the European list of "primeval forest relict beetles" (Eckelt et al. 2017). In France, the recent catalogue of saproxylic beetles (Bouget et al. 2019) gives it a value of 1, which indicates a common species.

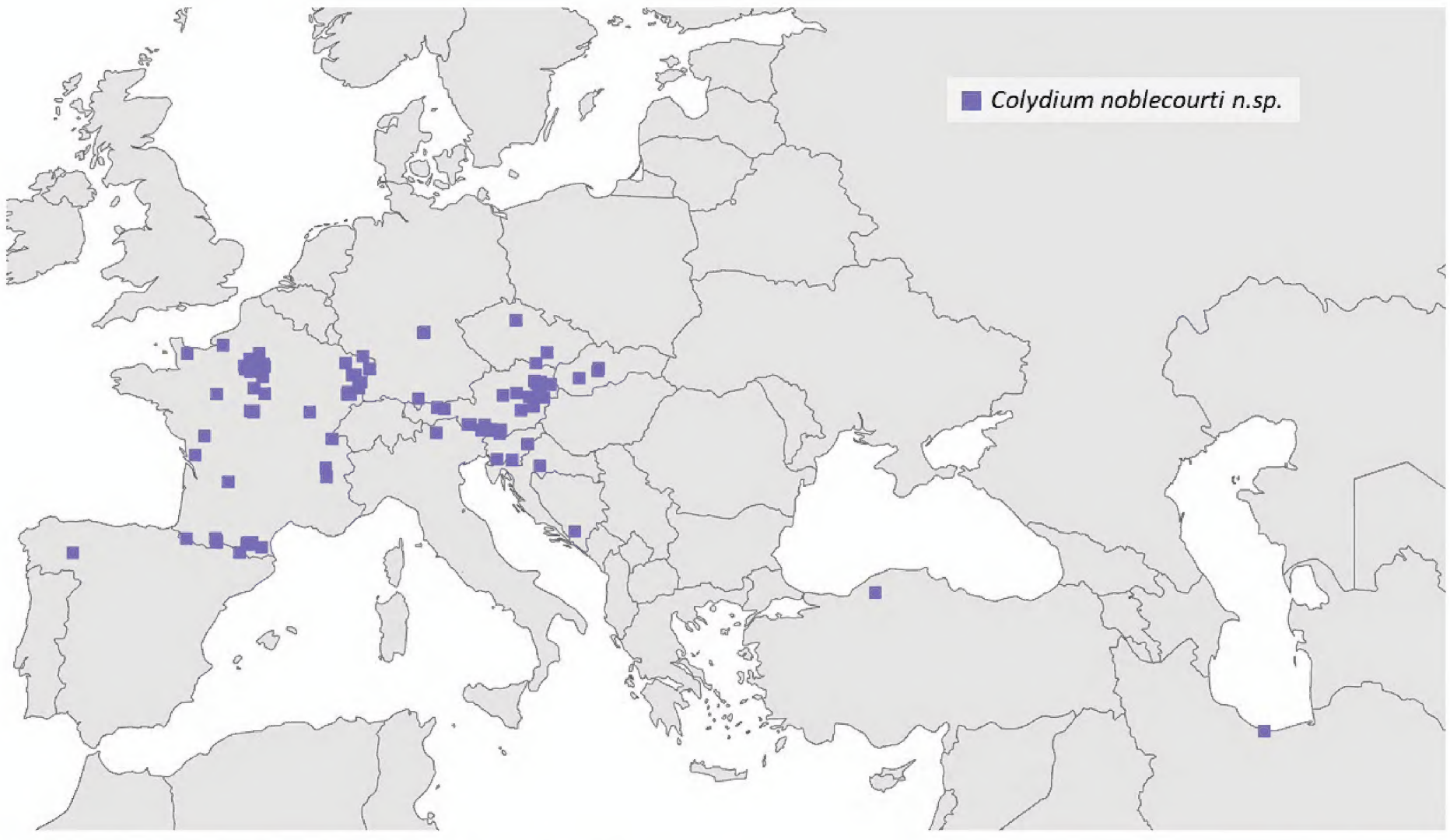


Figure 6. Geographical distribution of *Colydium noblecourti* sp. nov.

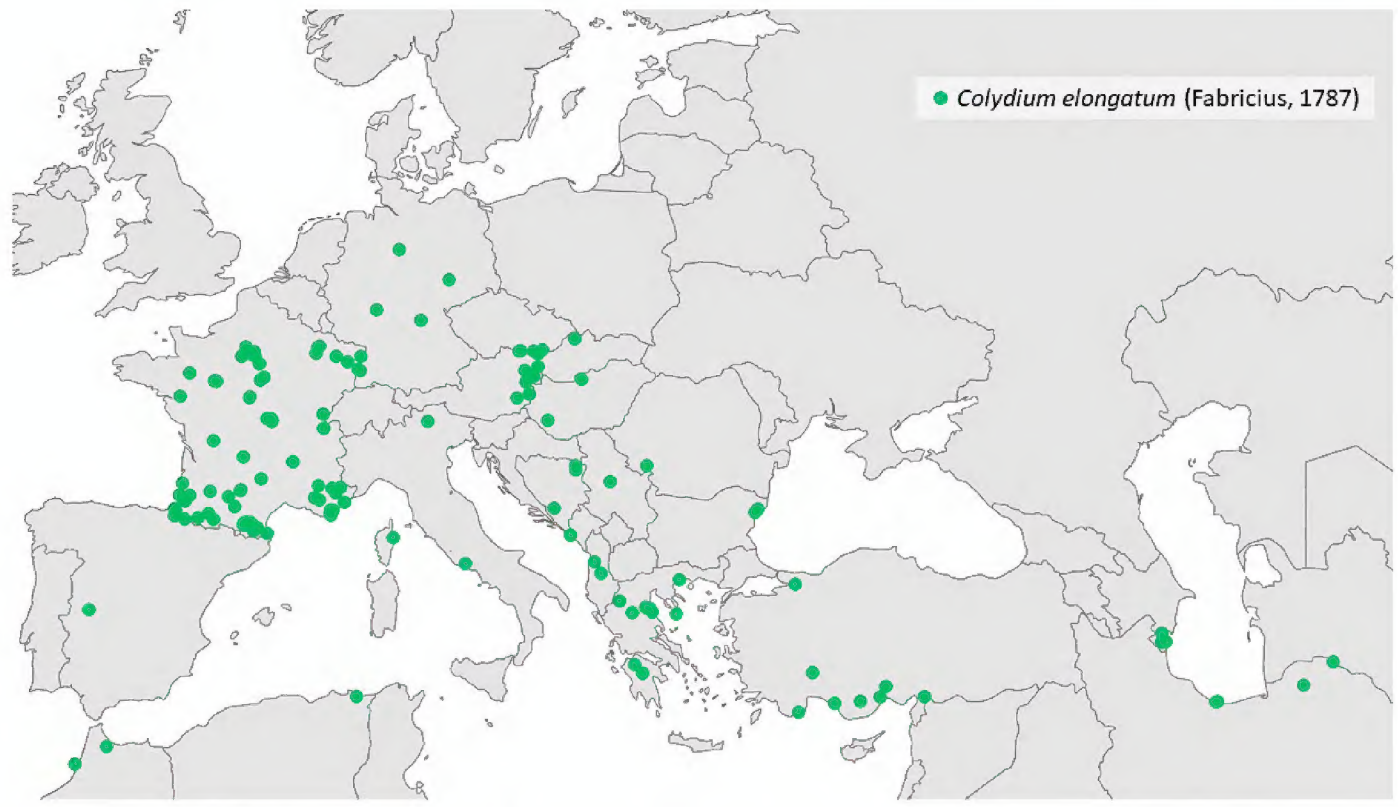


Figure 7. Geographical distribution of *Colydium elongatum* (Fabricius).

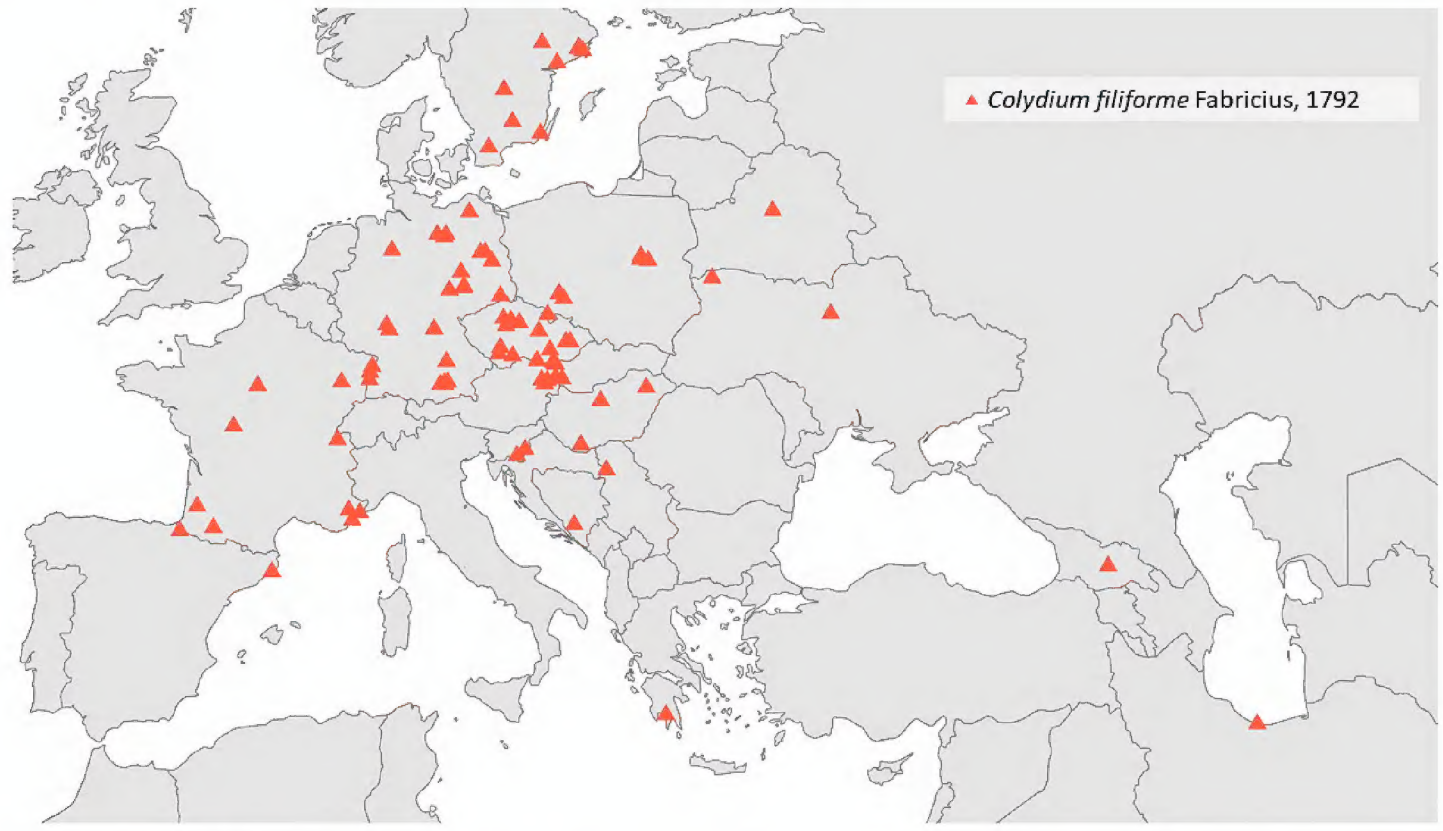


Figure 8. Geographical distribution of *Colydium filiforme* Fabricius.

Colydium filiforme is known in 23 countries in Europe (AB; AU; BE; BH; BU; BY; CR; CZ; FR; GE; GG; GR; HU; IT; LA; LS; NR; PL; SK; SP; ST; SV; SZ. Abbreviations according to Iwan and Löbl (2020)). It is a rare species in Western Europe, while it seems more common in Eastern Europe. According to Brustel (2014), this species is indicated as rare but widespread in France. However, despite studying more than 290 *Colydium* specimens from France, we identified only two French specimens of *C. filiforme*, one from Saint Auban (Dépt. Alpes-Maritimes) trapped in a *Pinus* stand and one from La Wantzeau (Dépt. Bas-Rhin) trapped in a riverine *Fraxinus* and *Quercus* forest. No specimens are known from Corsica, but the species might be found there (Fig. 8). It is included in the list of European "primeval forest relict beetles" (Müller et al. 2005; and the updated edition, Eckelt et al. 2017). This assessment confirms its high conservation importance. It is considered "near threatened" in Italy (http://www.iucn.it/scheda.php?id=-1991355085) and "endangered" in Norway (https://artfakta.artdatabanken.se/taxon/100702). In Spain, only a few localities are known to host the species (Dieguez-Fernandez et al. 2012). We were able to study the specimen mentioned in Recalde Irurzun (2015). In France, the recent catalogue of saproxylic beetles (Bouget et al. 2019) gives it a value of 3, which indicates a rare species of important conservation interest.

Conclusion

Widely distributed species can sometimes hide a complex of several cryptic species. Closely studying morphology and male genitalia in association with genetic analysis is an efficient way to detect new species. We believe that many species remain undiscovered in Europe, and are simply hidden among more common ones. In the material we gathered, we detected *Colydium noblecourti* sp. nov. in thirteen countries. We assume that *Colydium noblecourti* sp. nov. will be found in other European countries as well.

Acknowledgements

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